Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	
Wireless E911 Location Accuracy Requirements	PS Docket No. 07-114
E911 Requirements for IP-Enabled Service Providers	WC Docket No. 05-196

T-MOBILE USA, INC. COMMENTS ON FURTHER NOTICE OF PROPOSED RULEMAKING AND NOTICE OF INQUIRY ON LOCATION ACCURACY

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January 19, 2011

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I. INTRODUCTION AND SUMMARY

T-Mobile USA Inc. ("T-Mobile") is committed to delivering reliable 911 service to its customers. No call is as important as 911 and it is therefore critical that first responders receive the most accurate location information feasible so that they may render assistance as quickly and efficiently as possible. As part of its commitment, and in accordance with the *Second Report and Order*[1] adopted on the same day as this FNPRM/NOI,[2] T-Mobile is transitioning from the network-based E911 location systems that it, along with other GSM providers, initially implemented to provide location estimates for every handset. As it implements 3G and 4G networks, and over the next eight years, T-Mobile will deploy assisted GPS ("A-GPS"), which

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1 *In the Matter of Wireless E911 Location Accuracy Requirements; E911 Requirements for IP-Enabled Service Providers*, Second Report and Order, FCC 10-176, ___ FCC Rcd. ___ (rel. Sept. 23, 2010) ("Second Report and Order").

2 *In the Matter of Wireless E911 Location Accuracy Requirements; E911 Requirements for IP-Enabled Service Providers*, Further Notice of Proposed Rulemaking and Notice of Inquiry, FCC 10-177, ___ FCC Rcd. ___ (rel. Sept. 23, 2010) ("*FNPRM*").

allows for more accurate location estimates, especially in challenging rural environments and along highway corridors.

The eight year transition to A-GPS embraced by the *Second Report and Order* is the latest step in the continued evolution and deployment of E911 services – which has been a substantial success for consumers, public safety, the Commission and the wireless industry. According to NENA, one-third of the 240 million calls to 911 are placed over wireless. And over 95% of PSAPs have at least some Phase 2 E911 service. The *Second Report and Order* will result in continued improvements in E911 service, and will ensure that PSAPs have even more information that will help them interpret the location estimates they receive and to respond accordingly.

Successful implementation of the *Second Report and Order* will require substantial focused efforts and needs to be the centerpiece of improvements in E911 over that time period. The *Second Report and Order* itself already effectuates major stated goals of the *FNPRM* without any further FCC action. The network-wide implementation of A-GPS by all of the major GSM carriers will improve location accuracy in those areas where network-based estimates have been least precise and will *de facto* harmonize accuracy standards as all major carriers unite on handset-based technology, and ultimately, handset-based accuracy standards.

The *FNPRM* unfortunately threatens to distract from those efforts, reopening the prospect that, even before the eight-year transition is complete, the FCC may "move the goalposts" that were just set. At best, the *FNPRM* is premature, as the Commission's Communications Security, Reliability, and Interoperability Council ("CSRIC") is currently undertaking yet another review of location technologies, pursuant to its FCC-developed charter.

There are no ready or obvious complements to A-GPS, as was apparent after the National Telecommunications and Information Administration and the National Highway Transportation Safety Administration's National E911 Implementation Office completed the location technology review mandated by the NET 911 Act.[3] Some technologies that were highly touted by their proponents two years ago are already failing to become viable, and others have obvious operational challenges. As potential replacement or complementary technologies present themselves, the Commission must remember that any change that requires handset replacement cannot be implemented overnight and will require yet another long implementation schedule.

As it considers the issues presented by the *FNPRM*, the Commission must also take care to separate fact from vendor puffery, and to assess the potential benefits, if any, of added capabilities in the light of engineering realities. The President's just-issued Executive Order on improved regulation and regulatory review directs that an agency must "propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs" and "tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations."[4] Consistent with the President's Order and the Commission's obligations to engage

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[3] *See* 47 U.S.C. § 942(d)(2)(D), (J); The National E9-1-1 Implementation Coordination Office, *A National Plan for Migrating to IP-Enabled 9-1-1 Systems*, September 2009 ("Location Technology Report").

[4] Executive Order, Improving Regulation and Regulatory Review, *available at*: http://www.whitehouse.gov/the-press-office/2011/01/18/improving-regulation-and-regulatory-review-executive-order (rel. January 18, 2011) ("2011 Regulatory Review Executive Order"). By its terms, this Executive Order is not binding on independent agencies such as the FCC.

in reasoned decision making that is neither arbitrary nor capricious, the Commission must weigh both the benefits and costs of any new rules that it considers.

Moreover, E911 location objectives need to be operationally feasible. As T-Mobile explained in detail in previous comments in these dockets, and incorporates again here, there is no operationally feasible way to evaluate indoor accuracy on a local level in a manner similar to drive testing. The operational impediments of gaining access to large numbers of indoor locations and measuring ground truth have not changed since the Commission last sought comment in 2007.

Location accuracy will improve as A-GPS is implemented as set forth in the *Second Report and Order*, and A-GPS technology itself will continue to improve. T-Mobile will continue to improve its location capabilities as technologies improve and can deliver demonstrable benefits. However, at this time, T-Mobile believes the best course for the Commission would be to focus now on the implementation of the *Second Report and Order* and to evaluate potential changes only after the Commission can assess the impact of the *Second Report and Order*.

II. THE *FNPRM* IS PREMATURE AND MAY IMPEDE SOME BENEFITS OF THE *SECOND REPORT AND ORDER*.

The *FNPRM* was released on the same day as the *Second Report and Order*. Consequently, no one has had a chance to see how the changes mandated by the *Second Report and Order* will affect their ongoing efforts to improve E911 access to mobile phone users. The *FNPRM* also asks for comments on some issues – such as whether the network/handset distinction in accuracy standards should be eliminated – that will naturally be accomplished through implementation of the *Second Report and Order*.

A. The Commission Needs to Give Industry Time to Implement the *Second Report and Order* and to Assess Its Fruits.

Location accuracy will be improved and made more uniform simply through the implementation of the *Second Report and Order*. For carriers using network-based E911 solutions like T-Mobile, the *Second Report and Order* establishes a migration path from those technologies to the handset-based A-GPS solution. T-Mobile made clear in its comments leading to the *Second Report and Order* that it is undertaking such a migration. And, as T-Mobile explained in those comments, it will have to achieve at least 85% penetration of A-GPS handsets within five years to meet the *Second Report and Order*'s requirements for an average accuracy of 100 meters for 67% of calls in 100% of counties or PSAP service areas by January 2016.[5] The handset change out necessary to accomplish this transition to A-GPS will be accomplished as consumers upgrade from 2G to 3G and 4G services.[6]

As carriers transition to A-GPS, they will also transition from network-based accuracy standards to handset-based standards, moving toward a *de facto* unified standard. Thus the likely result of the *Second Report and Order* is that, at least for major nationwide carriers, all will be using similar A-GPS E911 location technologies across nearly their entire subscriber base by the end of the ordered eight-year transition, and likely obtaining similar location performance in each county or PSAP service area. Moreover, because PSAPs will also receive uncertainty estimates as a result of the *Second Report and Order*, they will have a greater ability to tailor their response to the specific location estimate, rather than relying on broad technology-based generalizations.

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[5] Reply Comments of T-Mobile USA, Inc. on the E911 Accuracy Remand, PS Docket No. 07-114, at 3 (Oct. 14, 2008); *see also* Ex Parte Letter from Thomas J. Sugrue, Vice President, Governmental Affairs, T-Mobile, PS Docket No. 07-114, at 2-3 (June 16, 2010).

[6] At this time, all of T-Mobile's new 3G and 4G handsets are A-GPS capable.

Inasmuch as the *Second Report and Order* already contemplates a handset change out for all non-A-GPS-capable handsets, the Commission should be extremely reluctant to order another handset change out, especially before it can fully evaluate the results of the *Second Report and Order*. Doing so would likely impose significant additional unnecessary costs on consumers and providers without an ascertainable benefit. In addition, continued refinements in GPS receiver performance and location algorithms, and the likely availability of additional navigation satellite systems will improve A-GPS capabilities during the eight-year transition – yet another reason the Commission should refrain from further mandates at this time.

B. CSRIC Is In the Process of Investigating Many of the Questions Posed in the *FNPRM*.

To the extent the *FNPRM* seeks comment on the state of autolocation technologies, either for CMRS or VoIP, CSRIC working group members are actively engaged in developing their reports on the transition to NG911 and location accuracy issues.[7] Those reports may render

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[7] CSRIC is directed by its charter to "develop and recommend best practices and actions the FCC can take that promote reliable 9-1-1 and enhanced 9-1-1 service" and to "analyze and recommend technical options to enable accurate and reliable dynamic E9-1-1 location identification for interconnected VoIP services." Charter of the FCC's Communications Security, Reliability, and Interoperability Council, filed March 19, 2009, *available at* http://www.fcc.gov/pshs/docs/advisory/csric/CSRC_charter_03-19-2009.pdf.

CSRIC Working Group 4C was directed by CSRIC to examine E9-1-1/Public Safety location technologies in use today, identifying current performance and limitations for use in NG Public Safety Applications; to examine emerging E9-1-1/Public Safety location technologies; and to recommend options to CSRIC for improvement of E9-1-1 location accuracy including implementation timelines. These recommendations should:

- Identify industry standards direction for location and ability to use location for next generation services and applications;
- Identify emerging location technologies, including combining multiple technologies to improve location accuracy;
- Identify when such technologies could be available;
- Identify security issues and vulnerabilities around future location technologies;
- Identify interactions with existing technologies and any backwards compatibility issues;
- Identify opportunities to apply next generation location technologies to current networks;

many of the *FNPRM*'s questions irrelevant or moot. The Commission should therefore avoid considering any changes to existing rules until those working groups' final reports have been completed and analyzed.

III. A-GPS REPRESENTS THE BEST POSSIBLE LOCATION TECHNOLOGY FOR E911 IN MOBILE HANDSETS.

There is broad industry consensus that A-GPS provides the best possible E911 location accuracy for mobile handsets. Moreover, A-GPS technology will continue to improve over time. Though some environments remain a challenge for A-GPS technology, none of the suggested alternative technologies are likely to provide better performance, either as standalone solutions or in combination with A-GPS. Nor is there any currently feasible way to implement vertical (z-axis) location accuracy.

As it reviews potential technological alternatives, the Commission must recognize that it is limited to solutions that are technically and economically feasible and justified by benefit-cost analysis. Technical and economic feasibility are "made necessary by the bar against arbitrary

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- Identify impacts to user equipment, networks, agencies, etc. for deployment of future E911/Public Safety location accuracy technologies; and
- Identify barriers to deploying these technologies.

CSRIC Working Group Description, Working Group 4C, *available at* http://www.fcc.gov/pshs/advisory/csric/wg-4c.pdf.

The reports of the CSRIC working groups assigned to investigate NG911 and location accuracy issues are not due until 12 months after the completion of the "best practices" working group report. *See* CSRIC Working Group Descriptions: Working Group 4B – Transition to NG9-1-1, *available at* http://www.fcc.gov/pshs/advisory/csric/wg-4b.pdf; Working Group 4C – Technical Options for E9-1-1, *available at* http://www.fcc.gov/pshs/advisory/csric/wg-4c.pdf; *see also* Working Group 4A, Best Practices for Reliable 9-1-1 and E9-1-1, Final Report, March 2010, submitted June 15, 2010, *available at* http://www.fcc.gov/pshs/docs/advisory/csric/WG-4A-Final-Report.doc. The location accuracy working group has also requested an additional two months because of the complexity of the issues involved. Steering Committee, Work Group 4C, Technical Options for E9-1-1 Location Accuracy, Presentation to CSRIC, October 7, 2010, *available at* http://www.fcc.gov/pshs/docs/advisory/csric/WG_4C-Technical_Options_for_E9-1-1_Location_Accuracy.ppt.

and capricious decision-making,"[8] and "[i]mpossible requirements imposed by an agency are perforce unreasonable."[9] While the Commission may rely on reasonable predictive judgments, those judgments must be based on record evidence.[10] Ultimately, "the FCC's 'conclusory statements cannot substitute for the reasoned explanation that is wanting in [the] decision.'"[11] Moreover, to be non-arbitrary, the Commission must also analyze the relative benefits and costs of any proposed new rule. The President, in an Executive Order issued January 18, 2011, underscored the importance of such analysis, directing that an agency must "propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs" and "tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations."[12] The President's Executive Order, while not itself binding on the FCC, makes clear that relative benefits and costs and the cumulative regulatory burden are important aspects of any regulatory problem. The "fail[ure] to consider an important aspect of the problem" would

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8 *Nuvio Corp. v. FCC*, 473 F.3d 302, 303 (D.C. Cir. 2006).

9 *Alliance for Cannabis Therapeutics v. DEA*, 930 F.2d 936, 940 (D.C. Cir. 1991).

10 *BellSouth Telecomms., Inc. v. FCC*, 469 F.3d 1052, 1060 (D.C. Cir. 2006) ("We cannot overlook the absence of record evidence . . . simply because the Commission cast its analysis as a prediction of future trends"; "the deference owed agencies' predictive judgments gives them no license to ignore the past when the past relates directly to the question at issue.").

11 *AT&T Corp. v. FCC*, 236 F.3d 729, 737 (D.C. Cir. 2001) (*quoting* Arco Oil & Gas Co. v. FERC, 932 F.2d 1501, 1504 (D.C. Cir. 1991)).

12 2011 Regulatory Review Executive Order.

render Commission action arbitrary and capricious,[13] and thus, the Commission must analyze whether the "relative harm . . . exceeded the relative benefits."[14]

A. A-GPS Is Likely to Continue to Improve.

Carriers and vendors are constantly improving their implementation of A-GPS. This involves improving algorithms and receiver sensitivities and evaluating the addition of other performance improvements, such as fine-timing assistance, extended ephemeris capability, and background tracking methods. As a result, most current A-GPS users can get a fix indoors near a window, in most residential or one-to-two story commercial buildings of wood frame construction, and in many dense urban environments. Modernization efforts are also underway to provide new satellite capabilities to ensure GPS remains the gold standard for positioning.[15]

Further improvements may also be possible. When new global navigational satellite systems, such as GLONASS[16] and Galileo,[17] come online, handsets incorporating those systems may be able to see more satellites in the sky, thus improving the likelihood that a given handset can be located as well as enabling greater location accuracy. Other possible improvements may become feasible, such as high-power terrestrial pseudo-GPS transmitters,[18] but such systems are

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13 *Motor Vehicle Mfrs. Ass'n of the U.S. v. State Farm Mutual Auto. Ins. Co.*, 463 U.S. 29, 43 (1983).

14 *BellSouth Telecomms.*, 469 F.3d at 1060.

15 *Cf.* Location Technology Report, Appendix B, at B-4-B-6, B-11.

16 GLONASS is the Russian global navigational satellite system. It has been in disrepair and is in the process of being improved. *See id.* at B-4.

17 Galileo is a European global navigational satellite system that is currently in development. It is expected to come online in the next few years. *See id.* at B-4, B-11.

18 These transmitters could be placed in areas where GPS signals are most challenged and could broadcast at much higher power levels than space-based sources, while potentially providing accuracy levels similar to GPS.

only now being explored and evaluated. It would be premature and unwise to modify performance standards based on possible future technology developments, just as it would be premature to require A-GPS to be paired with other technologies that may not present a meaningful improvement as compared with future A-GPS performance.

In addition to A-GPS improvements, carriers have also made improvements in the use of the timing and triangulation technologies that serve as fallback location technologies implemented today as complements to A-GPS. These methods help to ensure that callers who are unable to be located using A-GPS can still likely be located with medium accuracy (*i.e.*, some location information is provided, but not within the accuracy standards required for 67% of 911 calls). To that end, new solutions, such as Enhanced Round-Trip Time (E-RTT) have been introduced.[19] E-RTT uses base station measurements of the signal round-trip time. In some instances, these measurements can be made by all base stations serving a mobile device. If RTT measurements to several geographically dispersed base stations are available, which happens during soft handover, the mobile device location may be determined via trilateration. Though these fallbacks do not provide location estimates with as much accuracy as A-GPS, they operate in those environments where A-GPS is most challenged.

B. No Other Technologies Are Yet Beneficial Complements to A-GPS.

With the industry as a whole moving to implement A-GPS, the Commission should focus any additional evaluation on only those technologies that most logically and cost effectively complement A-GPS in areas in which A-GPS performance is most challenged. As of now,

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[19] E-RTT is a method used by UMTS carriers, including T-Mobile and AT&T. CDMA carriers such as Verizon similarly use a different supplemental technology, Advanced Forward Link Trilateration (AFLT).

however, there are no appropriate complements to A-GPS that would justify disrupting the current and ongoing implementation of the *Second Report and Order*. T-Mobile's assessment was essentially confirmed by the E911 Implementation Office's review of location accuracy technologies conducted pursuant to the NET 911 Act.[20]

An effective and practical high-accuracy location technology complement to A-GPS for E911 has yet to be developed. Many non-AGPS technologies have real world implementation problems, as discussed in greater detail below. The Commission and industry's emphasis should therefore be placed on migrating to and continuing to improve A-GPS performance consistent with the *Second Report and Order*. During this process, evolving location technologies can continue to be monitored in case further improvements become technically and economically feasible and can be practically implemented and supported.

Moreover, using any of the other proposed technologies (discussed below) in conjunction with A-GPS would impose a cost too great to be reasonable from a benefit-cost standpoint. None of the technologies discussed below provide a significant complementary location accuracy benefit across areas in which A-GPS performance is weaker. Furthermore, A-GPS is already costly to install in handsets; the additional network and equipment upgrades and operational costs required to implement the additional technologies discussed below would only further burden industry and slow implementation of the appropriate *Second Report and Order* upgrades.

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20 *See supra* note 3.

1. UTDOA

Uplink Time Difference of Arrival (UTDOA),[21] T-Mobile's primary network-based location technology, is not a productive complement to A-GPS. UTDOA requires huge investments in infrastructure and is least effective in rural areas, areas with low cell site density, highway corridor deployments, indoors, and areas with difficult terrain, such as large hills or mountains. Even though UTDOA has strengths in urban canyons and some mild indoor settings (providing medium-level accuracy location estimates within some buildings), it does not provide a significant improvement over A-GPS in any environment and struggles along with A-GPS in some common environments (e.g., deep indoors and heavily forested rural environments).

UTDOA accuracy varies in performance depending on the RF environment and the topography of the caller's location. Because it depends on terrestrial trilateration by surrounding cell sites, UTDOA also performs poorly in many rural and isolated areas with only a few, widely-dispersed cell sites; it also struggles along highways and in other areas with "string of pearls" cell site configurations. Similarly, indoor environments can be challenging for UTDOA because the building structure itself may limit the number of cell sites that can receive the handset's signal and reflections from walls can cause RF multipath issues that make it more difficult to accurately determine the correct time of arrival measurement.

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[21] Uplink Time Difference Of Arrival (UTDOA) location technology uses trilateration to determine a handset's location. Location Measurement Units (LMUs) measure the time of arrival of the handset's signal at multiple basestations (at known locations) within range of the handset. Those measurements are sent to a central processor which computes time differences to produce the location estimate. *See also* Location Technology Report, at B-3.

2. DTDOA

Downlink Time Difference of Arrival (DTDOA)[22] accuracy also varies with the environment of the caller as well as with the quantity and geometry of surrounding cell sites. T-Mobile initially pursued a form of DTDOA – E-OTD – which proved incapable of meeting the Commission's accuracy standards, even when averaged over large geographic areas.

Unlike UTDOA, in which only the time-of-arrival measurement uncertainty contributes to the system level error, DTDOA has a second error source in the uncertainty of the downlink transmission synchronization/measurement accuracy, because multiple transmission sources must be measured. In addition, the timing resolution and accuracy of a handset receiver is not optimized for precise timing measurements, especially in the case of significant multipath, introducing further uncertainties. Finally, DTDOA requires either a synchronous network (concurrent downlink transmissions from basestations) or a system of measurement devices deployed in the network to "virtually synchronize" the downlink transmissions of all basestations. All of these sources of error degrade the accuracy of location estimates. Accordingly, DTDOA can only approach and, in practice, will never match UTDOA accuracy.

Moreover like UTDOA, DTDOA is least effective in rural areas, areas with low cell site density, highway corridor deployments, indoors, and areas with difficult terrain. The mathematical realities of difficult cell site geometries and signal propagation, including multipath reflections, afflict DTDOA, just as they do UTDOA. This means that DTDOA is also challenged in some of the same environments as A-GPS, such as indoors (where multiple

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[22] Downlink Time Difference Of Arrival (DTDOA) uses the time-of-arrival of the downlink from multiple basestations (at known locations) measured by the handset. The handset sends the downlink measurements to a central processor which performs the trilateration calculations. As explained in this section, the timing of the basestation downlink signals must also be known, which introduces additional location error.

basestation transmissions cannot be heard by the mobile) and heavily forested rural areas (due to low cell site density). Thus, DTDOA is not a strong complement to A-GPS.

3. RF Fingerprinting

Radio Frequency Pattern Matching (RFPM or RF Fingerprinting)[23] is capable of medium to high accuracy location estimates in many outdoor areas, dense urban, urban, and some suburban localities where cell sites are sufficiently dense and RF scattering is complex. It can provide medium accuracy estimates in some mild indoor environments in urban settings where cell site density is high. With the exception of urban canyons, these high accuracy environments are the same environments where A-GPS already performs well. Because RFPM methods also share common weaknesses with A-GPS in many indoor environments and in heavily forested rural areas, RF Fingerprinting is not a suitable complement to A-GPS.

RF Fingerprinting has other weaknesses as well. RFPM techniques rely on careful and frequent calibration of the deployment area for any network or environment where changes regularly occur. Because such changes are common with most major network operators with large coverage areas, using RFPM would result in enormous on-going operational costs to maintain the accuracy of location estimates.[24]

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[23] Radio Frequency Pattern Matching (RFPM) utilizes RF measurements (e.g., signal strength, signal-to-interference ratio, link quality, time delay) made by a handset or the network. These measurements (RF "fingerprints") are sent to a central server which estimates the handset's location by statistically comparing them against an RF calibration database. This database must be carefully developed (typically by drive testing) and then maintained for each coverage area of interest to reflect changes in the network or surroundings of the handset to be located.

[24] UTDOA and RF Fingerprinting solutions are extremely expensive to deploy and/or operate and maintain and both are very limited in terms of competitive product offerings. Further competitive ventures are unlikely due to intellectual property restrictions and limited market opportunities in the U.S. and abroad.

4. WiFi Proximity

WiFi Proximity methods use WiFi access points at known locations to estimate the location of a caller. This method requires a high density of WiFi access points to function, as well as a constantly maintained database of access point locations, due to the dynamic nature of WiFi networks. As a result, WiFi Proximity only works in urban and dense suburban areas, and only with phones that have WiFi-receive capability. WiFi Proximity methods also share common weaknesses with A-GPS in many indoor environments (where access points cannot readily be located and documented) and in heavily forested rural areas (where access point densities are low).

Because the radii for WiFi access points are on the order of 100 meters, this technology can produce medium level accuracy. However, newer WiFi technologies and standards (such as IEEE 802.11n) are expected to extend coverage radii to several hundred meters, which will likely degrade location accuracy.

In addition, current E911 control plane interface standards do not support the use of WiFi Proximity location estimates for E911 purposes, and developing and maintaining the required database to support this method is operationally intensive and costly. WiFi operates on unlicensed band frequencies in dynamic networks, which are unplanned, unmanaged, and contain a mix of public and private access points. Mobile and portable WiFi access points have been in use for some time (*e.g.*, MiFi cards, smartphones with built-in WiFi access points, vehicles with access points), resulting in a growing number of access points that are not stationary. An area that is accurately calibrated today may not be accurate and reliable tomorrow. As a result, the reliability and effectiveness of this method for E911 purposes is questionable.

In summary, the WiFi Proximity method has considerable shortcomings: limited areas of applicability, potentially low reliability, only a subset of handsets that can be located, no standards support for E911, limited accuracy, and high cost. For these reasons, though the approach has found some success as a medium accuracy location method for some commercial-location-based smartphone applications, at present no vendors have even proposed using this method for E911.

5. DTV Triangulation

The sole proponent of using digital television (DTV) transmissions and tower locations to locate mobile phones – Rosum – has apparently ceased business operations.[25] Its proposed solution involved using a form of time-of-arrival trilateration based on DTV signals. But its method was never viable due to costs and logistical hurdles. The technology was not feasible because it would have required the installation of both a DTV receiver and a UHF antenna in each handset to receive the DTV transmissions, necessitating yet another handset change out. Moreover, broadcast stations frequently collocate their DTV antennas, which substantially undermines their usefulness for location triangulation. And DTV transmitters are not widely available in rural areas.

Furthermore, since DTV transmissions are not synchronized to an external timing standard, the Rosum solution required measurement devices to be deployed throughout the coverage area to monitor the actual downlink transmission timing. For these reasons, this method has never been proven to be a viable technology for E911 location purposes and the Commission should not consider it a feasible complement to A-GPS.

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[25] Rosum Corporation's website, www.rosum.com, is offline and corporate phone lines have been disconnected.

6. Wireless Bluetooth Beacon Proximity

Wireless Bluetooth Beacon Proximity creates a network of Bluetooth nodes that enables the mobile device's location to be determined when making a 911 call from inside a building. For high accuracy and continuous availability, Bluetooth beacons must be deployed every few meters within the building of interest. The beacons then broadcast their locations. During a 911 call from within the building, the mobile device obtains location information (either civic address or geo-coordinates) from the surrounding beacon nodes via Bluetooth connection. To use Bluetooth Beacon Proximity, the handset to be located must support Bluetooth functionality, be configured with the appropriate software, and the Bluetooth interface must be turned on.[26] WiFi connectivity between the beacon nodes and the management server that configures the beacon nodes is also required. Each PSAP must also support an interface to the vendor's location server. Because of its short range, Bluetooth Beacon Proximity is not suitable for outdoor applications.

While this approach offers the potential of enabling more accurate indoor location coverage, the enormous costs and practical impediments required to cover all buildings are prohibitive. Building owners would have to be willing to permit these devices to be added to their premises, and wired into the building power systems. The Commission has had experience, such as with cable and telecommunications "home run" inside wiring, with the difficulty in getting premises owners to permit (let alone pay for) modifications even in common areas and hallways.[27] Currently, even Bluetooth Beacon Proximity vendors recognize its limitations – they are targeting only limited deployments within a campus or specific high-importance enterprise of

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[26] If Bluetooth is not already turned on at the time of a 911 call – which can reduce battery life – it must be turned on during the 911 call, which has implications for the latency budget.

[27] *See, e.g., Telecommunications Services Inside Wiring*, First Order on Reconsideration & Second Report & Order, 18 FCC Rcd 1342 (2003), *Telecommunications Services Inside Wiring*, Report & Order & Second Further Notice of Proposed Rulemaking, 13 FCC Rcd 3659 (1997).

interest.[28] Therefore, at this time, Bluetooth Beacon Proximity is unsuitable as an A-GPS complement.

7. Other Proposed Technologies

Other technologies that have been proposed are either untested/experimental or are simply implementations of the above described technologies by different vendors.[29] It is critical that any 911 location technology must be thoroughly and scientifically evaluated. "Vaporware" claims by vendors for technologies that cannot deliver the promised results in the real world will not improve actual accuracy and reliability for first responders. Uncritically accepting such claims would most likely lead the Commission, public safety, and industry on a wild goose chase as vendors compete in making exaggerated performance claims in an attempt to convince the Commission to push the adoption of their purported solutions. At the end of the day, acceptance of unproven claims and technologies harms consumers who trust that the emergency response system is working at its peak for them.

C. Mandating Hybrid Technology is Unnecessary and Counterproductive.

In implementing the accuracy requirements in the *Second Report and Order*, industry should be allowed to use the technologies that work best with their networks, equipment, and user base. Verizon uses a combination of A-GPS and AFLT, for instance, while T-Mobile and AT&T use a combination of A-GPS and E-RTT.

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[28] One vendor proposing the Bluetooth beacon technology is WirelessWERX. Location Technology Report, Appendix B, at B-9.

[29] For instance, NAVIZON Virtual GPS, Cisco Wireless Location, Skyhook, and Ekahau, are each vendors for WiFi Proximity location technology. And Ubisense offers a technology involving RFID tags with nearby detectors for enterprise asset tracking applications. Ubisense's product has no apparent link to E911 services at this time. These additional technologies were described in the Location Technology Report.

If the Commission mandates certain kinds of hybrid technology or creates hybrid standards, it risks hamstringing companies, preventing them from using the technology that works best for them, while also delaying full implementation of the *Second Report and Order*. Moreover, mandating hybrid technologies will not speed availability of performance improvements to end users and could end up reducing overall performance levels. A technology combination may improve yield in some instances, but usually at the cost of reduced accuracy. Experience has shown that the result of combining a high accuracy and a medium accuracy location technology tends toward an accuracy near the mid-point of the two, *i.e.*, it is less accurate than the high accuracy technology alone.

Additional technologies also consume the latency budget (the time allowed for E911 location estimates). A-GPS typically requires most of the customary 30-second latency budget. And current E911 control plane interface standards do not allow launching more than one location technology position request at a time. As a result, even low-latency location technologies added sequentially to an A-GPS position would tend to reduce the high-accuracy A-GPS performance due to reduced GPS integration time. Standards enhancements to allow simultaneous location technology requests have been discussed, but practical implementation of such capability is many years away.

Carriers should be allowed to make the careful trade-offs that maximize overall location performance (accuracy, yield, and latency) for their own specific networks and technologies. A combination that may work well with a synchronous network may not work well with a non-synchronous network, for example. In other words, there is no "one size fits all" for every carrier and manufacturer and the Commission should avoid attempting to create one. Instead, the Commission should rely on the current accuracy standards, as set forth in the *Second Report and*

Order, to guide carriers and manufacturers to solutions that ensure the highest level of location system performance possible.

D. Accurate Elevation Information Is Still Unattainable.

While the *FNPRM* seeks comment again on vertical (z-axis) location estimates, it fails to even acknowledge the engineering reality that T-Mobile presented in its 2007 comments[30] – no current technology can deliver elevation estimates that are useful to PSAPs. Even under ideal conditions, GPS cannot provide elevation information within less than 70 meters (about 250 feet or 25 stories).[31] Such ideal conditions would typically be encountered in outdoor rural settings, where the use of such information is least helpful. These limitations make GPS elevation estimates virtually useless to first responders. Nor can other network-based location technologies provide elevation estimates because the location measurement units reside in essentially the same geographic plane as the mobile handset that is being located.[32]

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30 Comments of T-Mobile USA, Inc. on Section III.B of the Wireless E911 Location Accuracy NPRM, PS Docket No. 07-114, WC Docket No. 05-196, at 11 (August 20, 2007) ("2007 T-Mobile Comments"); *see also* Comments of The Alliance For Telecommunications Industry Solutions' Emergency Services Interconnection Forum, PS Docket No. 07-114, WT Docket No. 94-102, WC Docket No. 05-196, at 5 (August 20, 2007) (noting that "currently no industry criterion exists for elevation" and "before such information could be included in the location standard, greater research and development must occur").

31 Global Positioning System Standard Positioning Service Performance Standard, Assistant Secretary of Defense for Command, Control, Communications, and Intelligence, at 13 (Table 3-3) (October 2001). This specified 77-meter error range is considered ideal and actual performance will tend to be worse, for example, in urban settings, because of limited sky availability. In addition, the specified vertical accuracy is relative to the 'WGS84 Ellipsoid' – not true elevation above sea/ground level. Conversion to elevation above ground/sea level would add more error.

32 For example, UTDOA uses towers that, for triangulation purposes, are all essentially at the same height. The range of error for z-axis estimates, even if they could be made, would therefore be expected to be very large.

In addition to technology shortcomings in producing accurate elevation estimates, PSAPs have no capacity to use elevation information. Even if these highly inaccurate elevation estimates were to become accurate enough to pinpoint location within, for example, ten meters (over 30 feet), to use such data, PSAPs would have to have mapped the ground-level elevation above mean sea level of their service areas, as well as the height of the floors in each multistory building (recognizing that the height of a floor can vary from building to building and even within a building). These types of maps would be costly to create and integrate into public safety's geographic information systems. Finally, current data formats for sending location to a PSAP do not support transmission of elevation and therefore a change to the relevant standards would be required. For these reasons, there is no reasonable prospect that z-axis (elevation) measurements will be able to tell a PSAP "which door to kick in" on which floor in response to a 911 call.

IV. INDOOR ACCURACY STANDARDS AND TESTING REMAIN TECHNICALLY INFEASIBLE.

The *FNPRM* asks several questions about indoor accuracy and testing mandates. As T-Mobile has stated in previous comments in this docket,[33] it would not be technically feasible to meet the accuracy requirements in the *Second Report and Order* if the Commission were to mandate stringent indoor location accuracy requirements. Moreover, it is not feasible to conduct indoor testing in a manner similar to outdoor testing, which uses a large number of test points.

Indoor environments are significantly more challenging than outdoor environments in terms of generating accurate location estimates. Typically, GPS cannot be used because satellite reception by the handset is insufficient inside many buildings; indoor handsets are also less likely

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[33] 2007 T-Mobile Comments, at 13-14. T-Mobile incorporates those comments by reference.

to be received by multiple cell towers, making network-based solutions less accurate. Indoor environments can also dramatically attenuate RF transmissions – 30 to 50 dB of attenuation is not uncommon, depending on the type of building and the building materials. Further, indoor environments are plagued with increased RF multipath as signals frequently bounce off walls and windows, compromising the ability to resolve signal arrival times for A-GPS or for network-based location technologies. Multipath degrades location estimates by skewing the timing measurements used to calculate location.

Unlike outdoor data collection which can be performed by drive testing, there is no feasible way to perform indoor testing on any large scale. ESIF recently carefully studied and reported on indoor testing[34] and confirmed what industry has been saying: indoor testing on a large scale is not feasible. There are many significant technical, logistical, and practical issues associated with empirically measuring indoor performance:[35]

- Establishing accurate ground-truth is enormously complex, time-consuming, and costly;
- Getting widespread access to indoor facilities is extremely difficult and is compounded by privacy and security concerns; and
- Indoor testing is counter to OET Bulletin No. 71's admonition to keep testing methods "efficient, reliable, simple, [and] cost-effective."[36]

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34 Emergency Services Interconnection Forum, Alliance for Telecommunications Industry Solutions, *Approaches to Wireless E9-1-1 Indoor Location Performance Testing*, ATIS-0500013 (February 23, 2010) ("ESIF Indoor Testing Report").

35 *See id.* at 27.

36 OET Bulletin No. 71, Guidelines for Testing and Verifying the Accuracy of Wireless E911 Location Systems, at 5 (April 12, 2000).

Establishing a requirement for indoor test calls at the local level would simply exacerbate the known problems, and would add no additional benefit to the public given the underlying technological limitations.

ESIF recommends that, if indoor testing is to be conducted, optimal performance could take the form of establishing baseline performance expectations in *representative* indoor environments.[37] While T-Mobile maintains that indoor testing mandates should not be implemented at this time, T-Mobile agrees with the ESIF recommendation that testing representative indoor environments would be far preferable to repetitive application of indoor testing at the local level.

V. THE COMMISSION SHOULD NOT MANDATE RE-TESTING IN ALL AREAS BECAUSE DATA VALIDITY DOES NOT EXPIRE.

As Corr Wireless has argued,[38] periodic testing is not necessary. Once initial data is collected indicating certain accuracy levels have been achieved, that data does not lose validity. In fact, performance generally tends to improve rather than degrade over time. As it did in the *Second Report and Order*, the Commission should recognize that carriers are constantly reevaluating their location performance as they monitor and track key indicators on an on-going basis. (The *Second Report and Order* requires carriers to monitor performance once compliance has initially been reached through the trending of uncertainty estimates at the local level.) Requiring periodic re-testing would therefore be unnecessary and impose a huge burden. At a minimum, the Commission is obligated by the Paperwork Reduction Act to evaluate the *Second Report and Order* mechanisms before imposing additional information collection requirements.

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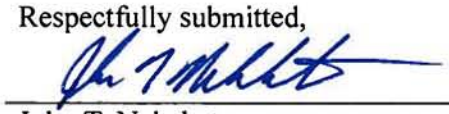
37 ESIF Indoor Testing Report, at 27.

38 Comments of Corr Wireless, PS Docket No. 07-114, at 6 (filed Aug. 14, 2007) (cited in *FNPRM* at ¶ 21).

VI. CONCLUSION

T-Mobile is committed to its ongoing implementation of the location accuracy requirements set forth in the *Second Report and Order* which in and of themselves will improve location accuracy in many areas, particularly in rural areas. The eight year transition to A-GPS set forth in the *Second Report and Order* will naturally move industry toward a unified accuracy standard, and will allow accuracy to improve as A-GPS solutions continue to improve. To the extent the *FNPRM* seeks only to refresh the record on location technology, T-Mobile reiterates that A-GPS represents the best possible E911 location technology for mobile handset users. At this time, no other location technology has been shown to be a feasible complement or replacement for A-GPS. Nor has the practical difficulty of indoor accuracy changed – indoor environments remain highly challenging for reliable testing. T-Mobile will continue to evaluate E911 location solutions as they are developed, with an eye toward seeing which, if any, offer implementable improvements above and beyond A-GPS. In light of the few changes seen to date in location accuracy technology since 2007, however, the Commission should refrain from imposing new location accuracy mandates at this time, and should instead allow industry to implement the requirements of the *Second Report and Order*.

Respectfully submitted,



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January 19, 2011